SNS Vacuum Control and Interface

Part I. Review on proposed common SNS Vacuum Control System Architecture and Standardization Consideration
Part II. SNS Ring Vacuum Control System Configuration and Control Software Development Status

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# Standardization Benefits

- To share software and hardware resources among the SNS collaborating labs

- To minimize the number of PLC or device controller manufactures and models

- To avoid redundant effort to develop control software

- To reduce operation effort to support multiple PLC or device controller models

- To obtain the best pricing by pooling of orders

- To concentrate efforts to develop best practices

Proposed SNS Vacuum Control System Architecture
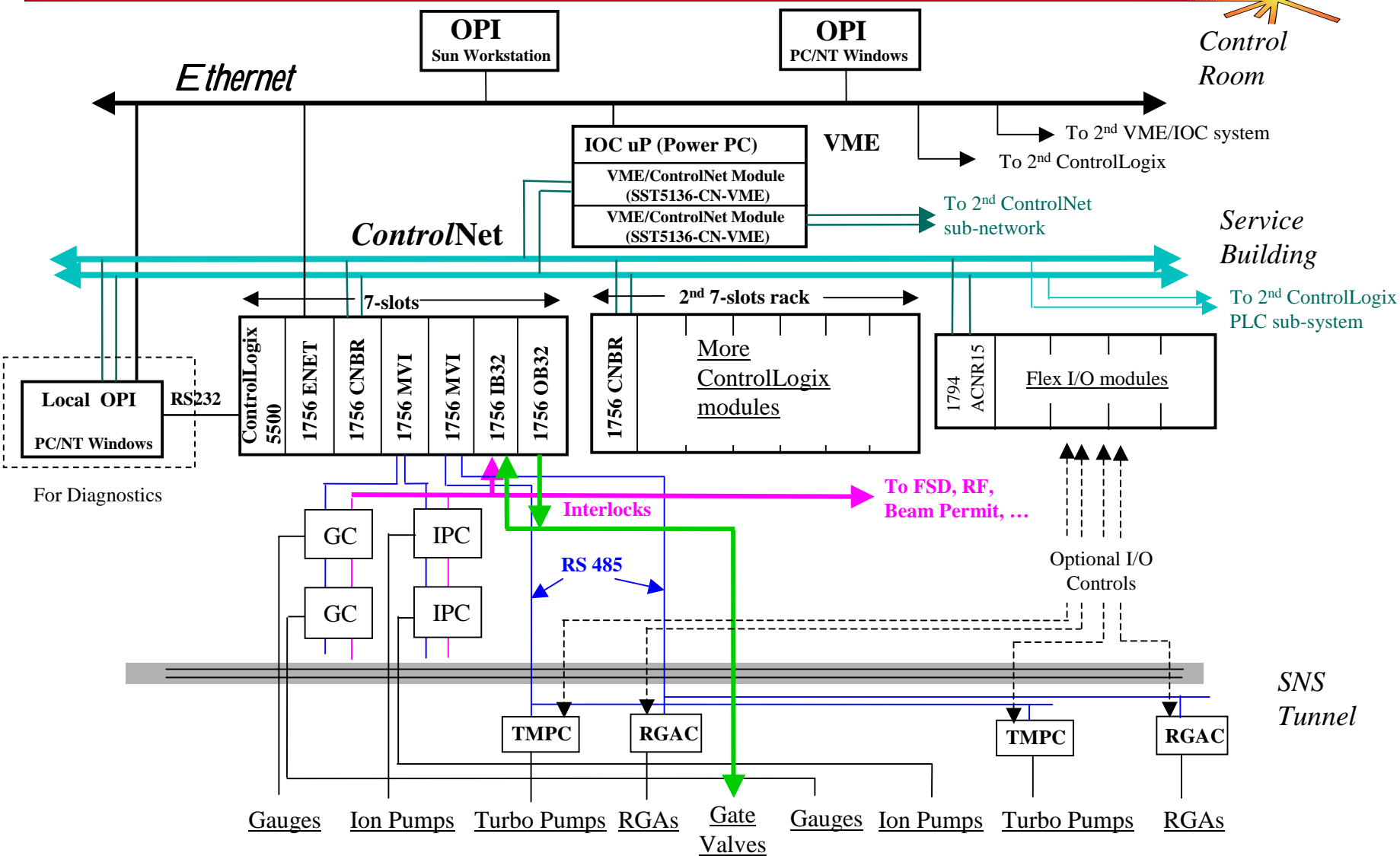
Proposed SNS Vacuum Control System Architecture - Features
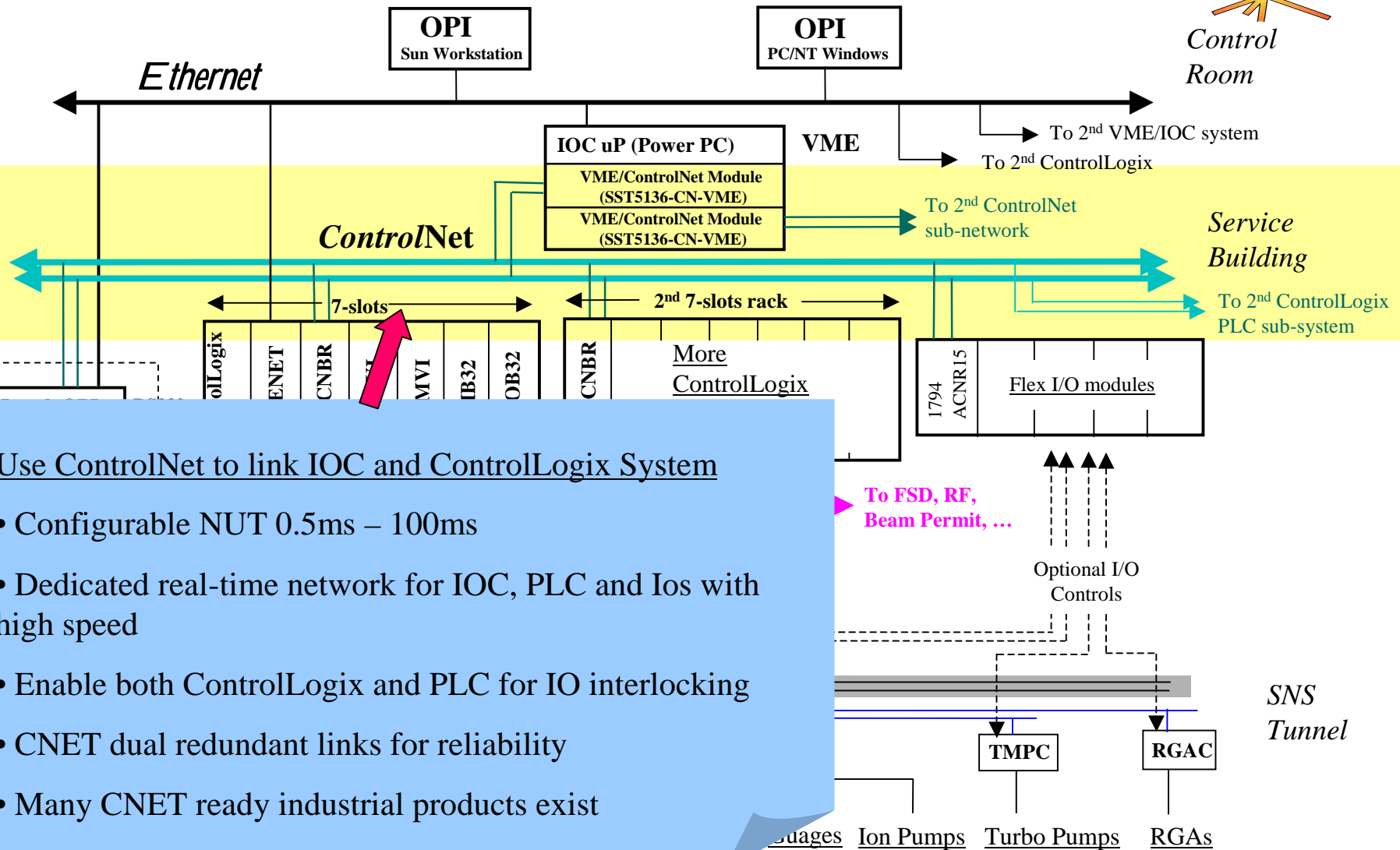
Proposed SNS Vacuum Control System Architecture - <u>Features</u>

OPI
Sun Workstation

OPI
PC/NT Windows

Control Room

Ethernet

To 2nd VME/IOC system

IOC uP (Power PC)   **VME**

To 2nd ControlLogix

VME/ControlNet Module
(SST5136-CN-VME)

VME/ControlNet Module
(SST5136-CN-VME)

To 2nd ControlNet
sub-network

ControlNet

Service Building

2nd 7-slots rack

To 2nd ControlLogix
PLC sub-system

slots

ControlLogix 5500

1756 ENET

1756 CNBR

VI

32

B32

NBR

More
ControlLogix

R15

Flex I/O modules

RS232

Local OPI
PC/NT Windows

For Diagnostics

Use Ethernet

- Remote and fast PLC programming upload/download and status monitoring

- Enable future real-time IO over Ethernet

GC

GC

SNS Tunnel

TMPC

RGAC

TMPC

RGAC

Guages   Ion Pumps   Turbo Pumps   RGAs   Gate Valves   Guages   Ion Pumps   Turbo Pumps   RGAs

Features
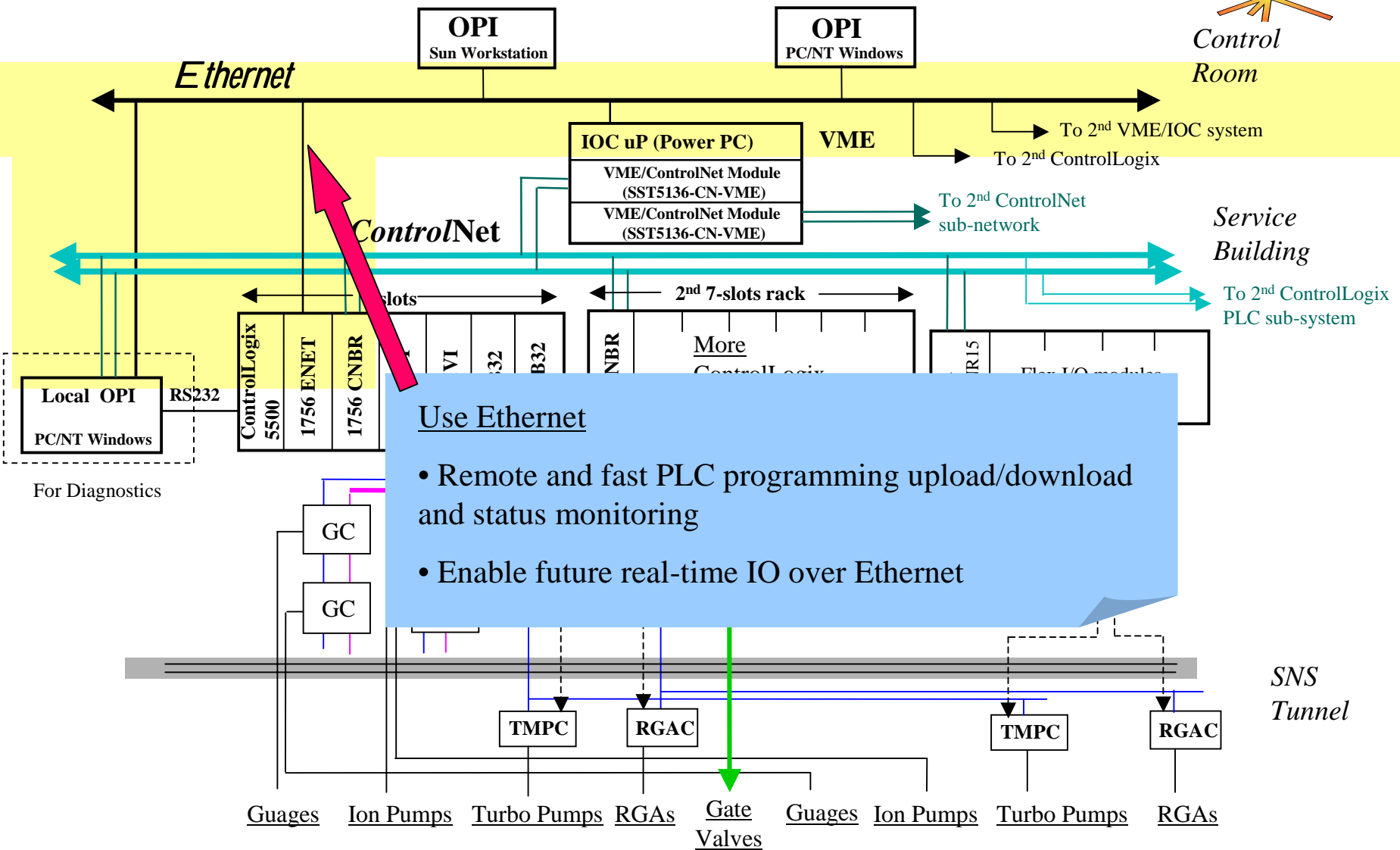
Local Control Capability
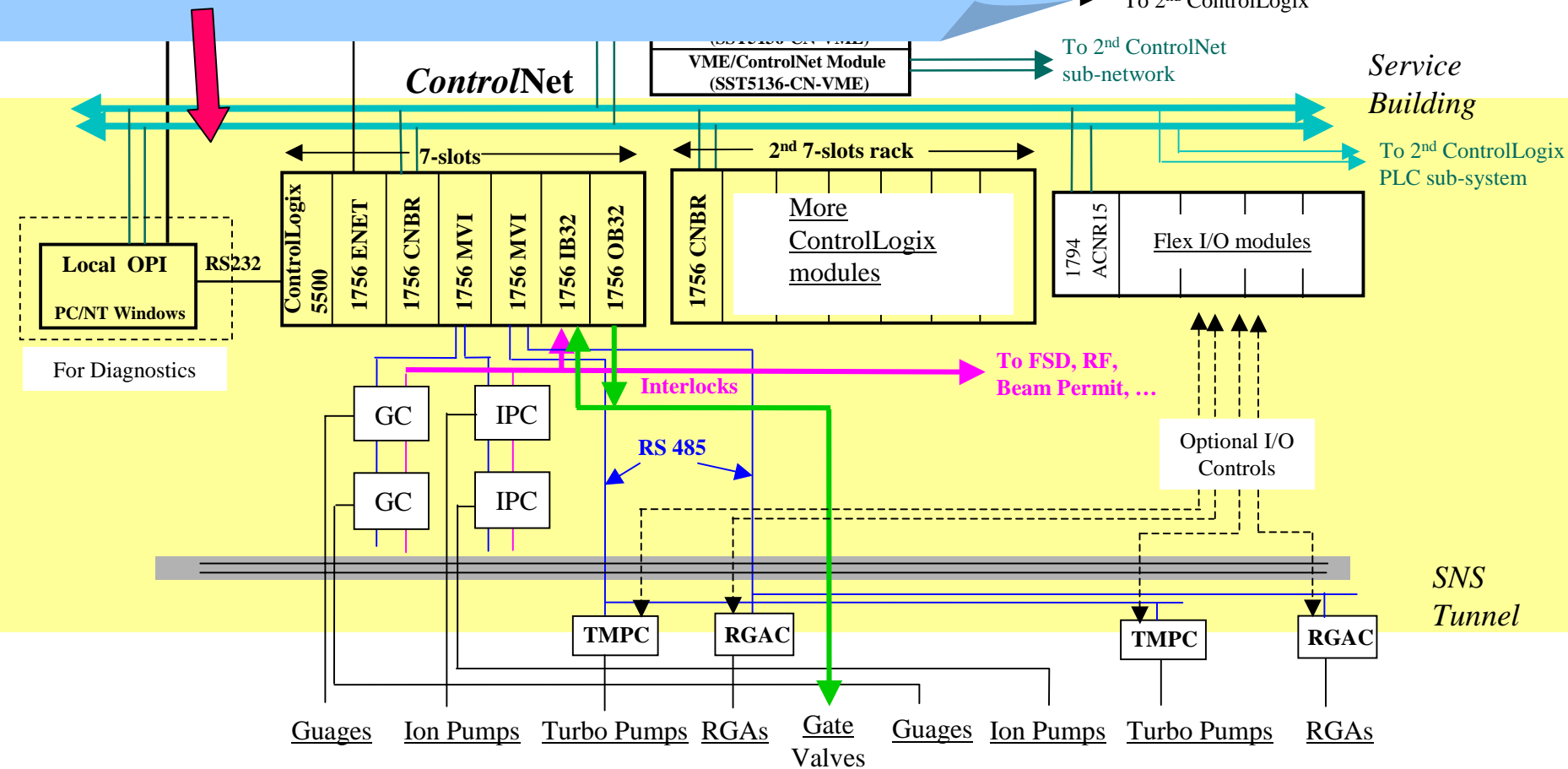
• Ethernet or IOC temporary down will not impact on vacuum interlock system and vacuum system operations

• ControlLogix program scan rate: 0.08ms/1K Boolean instructions

• With CNET link, average I/O scan time per I/O chassis is 0.5ms (8 word In and 8 word Out)

• Minimum time for NUT needs 2ms

To 2nd VME/IOC system

To 2nd ControlLogix

To 2nd ControlNet sub-network

VME/ControlNet Module
(SST5136-CN-VME)

*Control*Net

Service Building

To 2nd ControlLogix PLC sub-system

7-slots

2nd 7-slots rack

| ControlLogix 5500 | 1756 ENET | 1756 CNBR | 1756 MVI | 1756 MVI | 1756 IB32 | 1756 OB32 | 1756 CNBR | More ControlLogix modules | 1794 ACNR15 | Flex I/O modules |

Local OPI
PC/NT Windows

RS232

For Diagnostics

GC

IPC

Interlocks

To FSD, RF, Beam Permit, …

GC

IPC

RS 485

Optional I/O Controls

SNS Tunnel

TMPC   RGAC

TMPC   RGAC

Guages   Ion Pumps   Turbo Pumps   RGAs   Gate Valves   Guages   Ion Pumps   Turbo Pumps   RGAs

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SNS Vacuum Instruments Interface and Control Workshop, August 15 –16, 2000, ORNL   6

Standardization at OPI

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                    OPI                    OPI
               Sun Workstation         PC/NT Windows
Ethernet
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Control Room
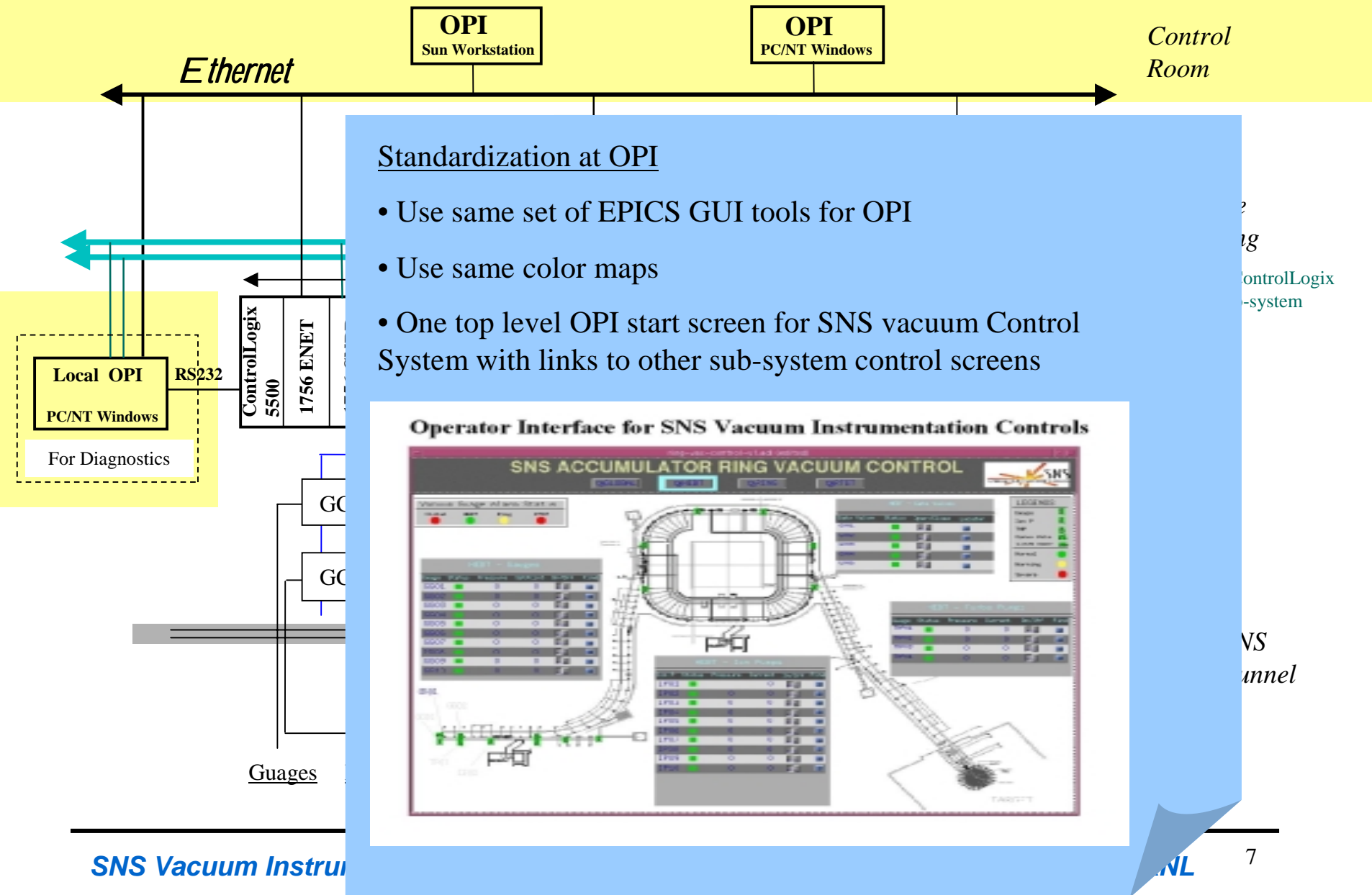
Standardization at OPI

• Use same set of EPICS GUI tools for OPI

• Use same color maps

• One top level OPI start screen for SNS vacuum Control System with links to other sub-system control screens

ControlLogix sub-system

Local OPI RS232

PC/NT Windows

For Diagnostics

ControlLogix 5500

1756 ENET

GC

GC

NS unnel

Guages

Operator Interface for SNS Vacuum Instrumentation Controls

SNS ACCUMULATOR RING VACUUM CONTROL

Standardization at EPICS Database & device drivers

Standardization at EPICS databases & drivers

• Implement vacuum device special record types, such as IonPump record, Guage record for modular approach

• Use same device controller remote interface, such as RS485, to share EPICS device and driver support

Example of a Ion Pump

• Set On/Off (O)
• OnLine/OffLine Status (I)
• HV On/Off Status (I)
• Start/Protect Mode Status (I)
• Two Set-point On/Off Status (I)
• Pump Pressure Readback (I)
• Pump Current Readback (I)
• Pump Voltage Readback (I)

Standardization at Rack Configuration

SNS

Control Room

OPI
Sun Workstation

OPI
PC/NT Windows
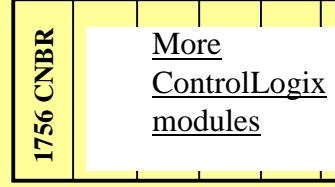
Ethernet

To 2nd VME/IOC

IOC uP (Power PC)

VME

VME/ControlNet Module
(SST5136-CN-VME)

VME/ControlNet Module
(SST5136-CN-VME)

*Control*Net

7-slots

2nd 7-slots rack

ControlLogix 5500	1756 ENET	1756 CNBR	1756 MVI	1756 MVI	1756 IB32	1756 OB32	1756 CNBR

More ControlLogix modules

Local OPI
PC/NT Windows

RS232

Guages   Ion Pumps   Turbo Pumps   RGAs   Gate Valves   Guages

TMPC   RGAC
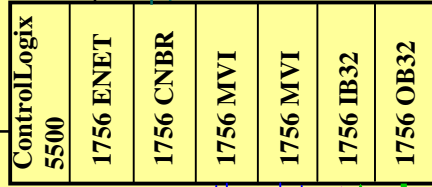
Standardization at Rack Configuration

• Use same size of ControlLogix rack (7-slot)

• Use same ordering from L to R for ControlLogix modules or Flex I/O modules installations
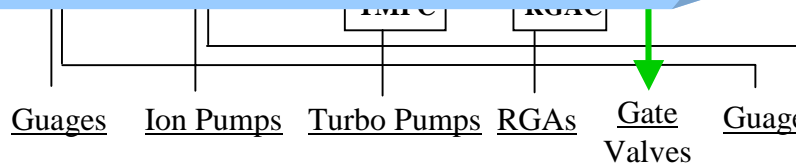
SNS Ring Vacuum Control Test Stand is designed for SNS vacuum instrumentation control software development. It also has been used for evaluations of vacuum device controllers, Allen-Bradley Programming Logic Processors, and ControlNet.

Vacuum Device Objects

Ion Pump (IP)

- Set On/Off (O)
- OnLine/OffLine Status (I)
- HV On/Off Status (I)
- Start/Protect Mode Status (I)
- Two Set-point On/Off Status (I)
- Pump Pressure Readback (I)
- Pump Current Readback (I)
- Pump Voltage Readback (I)

Cold Cathode Gauge (CC)

- High Voltage On/Off (O)
- Set Trip Point Level (O)
- Pressure Reading (I)
- Set-point Level Readback (I)
- Relay Contact Status (I)

Thermocouple-type Gauge (TC)

- Pressure Reading (I)
- Set-point Level Readback (I)
- Relay Contact Status (I)

ControlNet

Device & Driver support

Sector Valve (SV)

- Open/Close valve (O)
- Reset to clear fault (O)
- Valve Open/Close Status (I)

Device Control Interface

Vacuum Instrument Controller Interface Survey

Equipment Type	Vendor & Model No.	Interfaces Available				Comments
		Discrete & analog I/O	RS-232 RS-422 RS-485	Device Net	IEEE 488	
Ion Pump Controller	Varian MultiVac	X	X			Probably meets RHIC spec
	Physical Electronics (PHI)	X	X			Probably meets RHIC spec
Vacuum Partial Pressure Analyzer	MKS / Pfeiffer / Leybold	?	X			RS-485 (per RHIC spec). Could not find on web
Vacuum Gauge Controller	Varian Multi-Gauge	X	X			Probably meets RHIC spec
	MKS Type 146 Cluster Gauge	X	X			Probably meets RHIC spec
	Pfeiffer MaxiGauge	X	X			Probably meets RHIC spec. Not much info on web
	Granville-Phillips Series 360 Stabil-Ion	X	X		X	Spec'ed in LANL cost estimate
Turbo Pump Controller	Varian	X	X			Probably meets RHIC spec
	Pfeiffer	?	?			RS-485? Not much info on web
	Leybold	?	?			Couldn't find enough info on web

SNS Ring Vacuum Device Counts

SNS Ring Vacuum Devices

	SV	CC	TC	GC	IP	IPC	TMPs	RGAs
HEBT	5	11	6	6	20	10	5	0
RING	8	16	16	8	42	21	8	8
RTBT	4	10	6	5	12	6	2	1
TOTAL	17	37	28	19	74	37	15	9

SNS Ring Vacuum Control System - *Configuration*

• 3 IOCs (one for each section, HEBT, Ring and RTBT during the commissioning) – one IOC would be enough for operation

• 4 ControlLogix 5500 systems (HEBT – 1; Ring – 2; RTBT – 1)
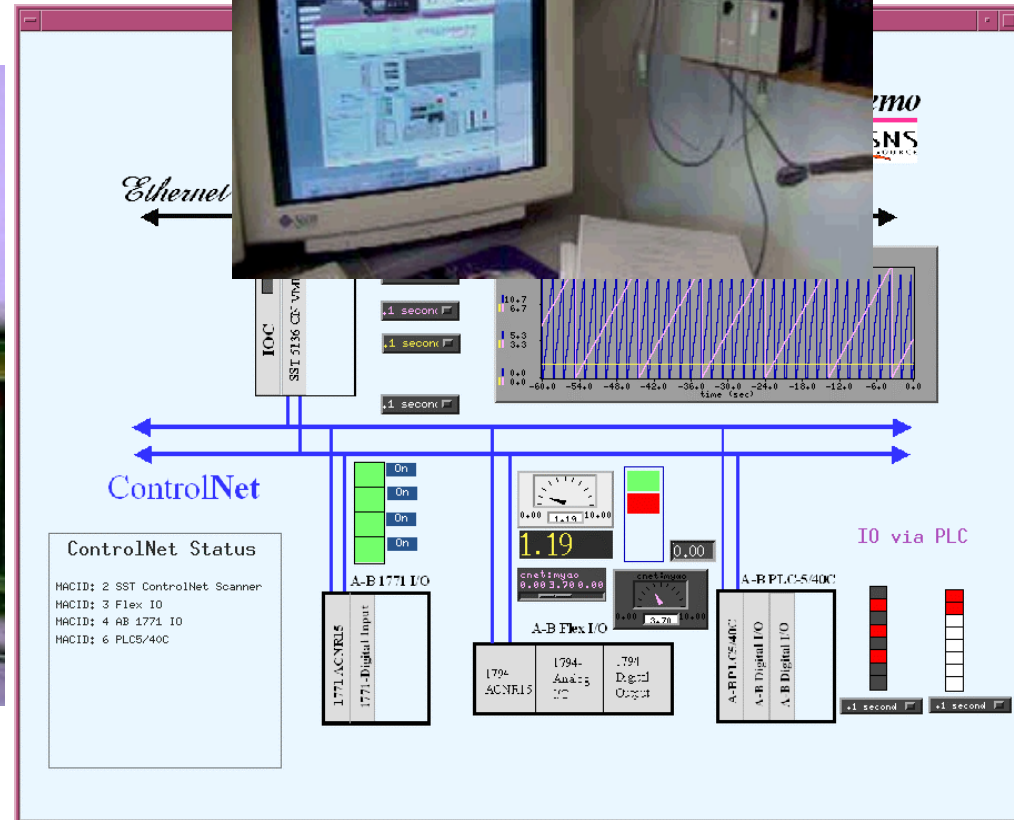
• 3 ControlNet Networks (HEBT – 1; Ring – 1; RTBT – 1)

SNS Vacuum Control System - *ControlNet*
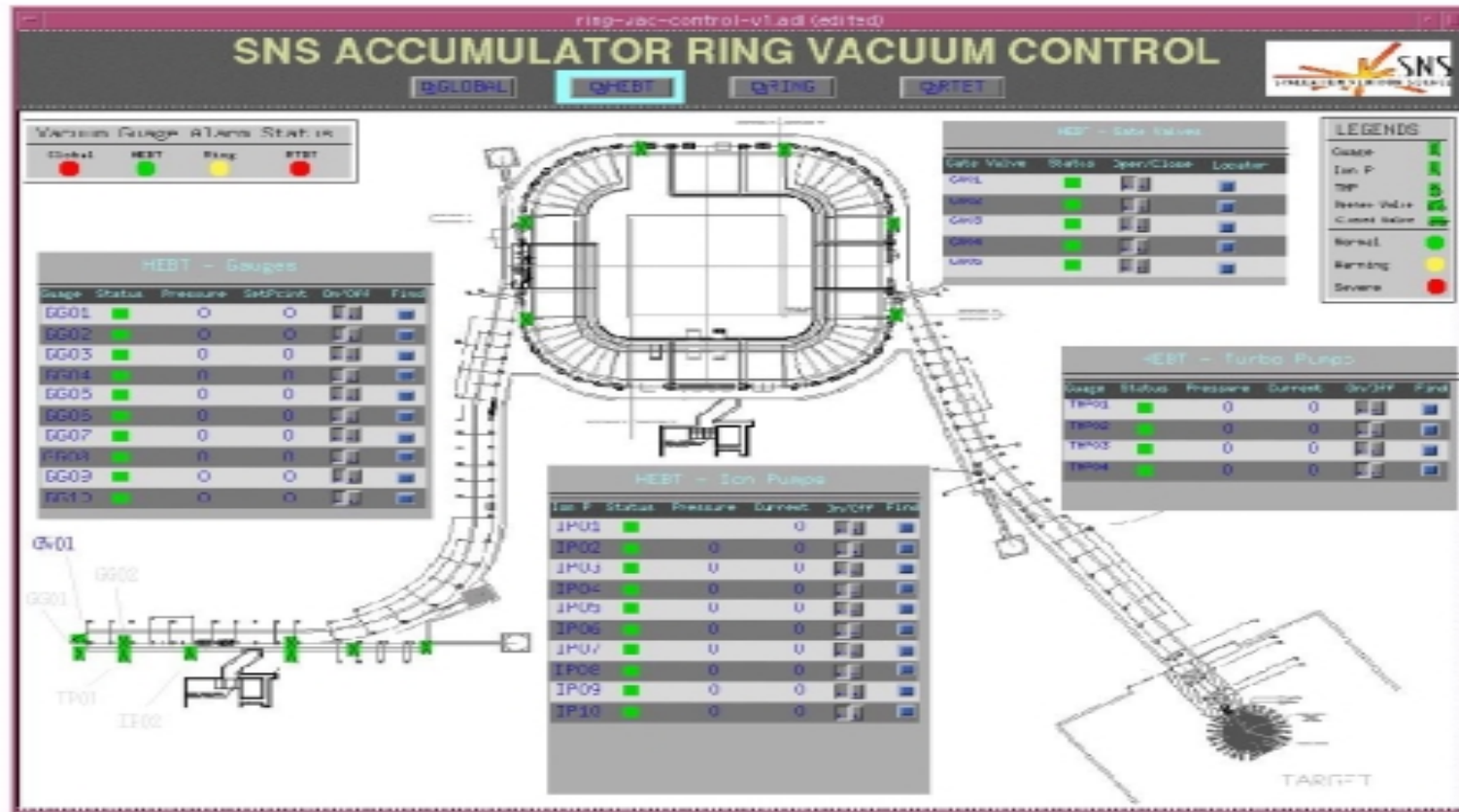
EPICS/ControlNet Testing System

SNS Vacuum Control System - *OPI*

EPICS OPI Prototype for SNS Vacuum Control

Operator Interface for SNS Vacuum Instrumentation Controls

SNS Vacuum Control System - *OPI*

Activity Description	Orig Dur	Early Start	Early Finish
1.0 Spallation Neutron Source Project			
1.9 Integrated Control Systems			
1.9.5 Ring Control Systems			
1.9.5.4 Vacuum System Controls			
Vac System I O C Hardware	498	01AUG00	31JUL02
Vac System Controls Design -Summary	249*	20FEB01	19FEB02
Vac System Controls Fabrication -Summary	157*	12AUG02	31MAR03
Vac System Controls SW/HW Test-Summary	368*	12DEC02	03JUN04
Vac System Controls Install & Test Complete	0		11JUN04
Vac System Controls Ready for RTBT Syst Test	0		11JUN04
HEBT			
HEBT Vacuum Software Design & Procurement	125	20FEB01	16AUG01
HEBT Vacuum Software Fabricate	84	06SEP02	09JAN03
HEBT Vacuum SW/HW Test - Summary	265*	10JAN03	03FEB04
*[HEBT Vacuum - I C D - Prelim/Final]	41*	20FEB01	17APR01
*[HEBT Vac HW Install & Test- Summary]	265*	10JAN03	03FEB04
*[HEBT Vacuum Gauge Install & Test]	124*	01AUG03	02FEB04
Ring			
RING Vacuum Software Design & Procurement	100	18APR01	10SEP01
RING Vacuum Software Fabricate	84	27NOV02	31MAR03
RING Vacuum SW/HW Test - Summary	292*	01APR03	31MAY04
*[Ring Vacuum I C D - Prelim/Final]	64*	18APR01	19JUL01
*[Ring VAC Hardware Test - PLC]	124*	01APR03	25SEP03
*[Ring Vac HW Install & Test - Summary]	291*	02APR03	31MAY04
RTBT			
RTBT Vacuum Software Design & Procurement	124	17AUG01	19FEB02
RTBT Vacuum Software Fabricate	84	12AUG02	11DEC02
RTBT Vacuum SW/HW Test - Summary	368*	12DEC02	03JUN04
*[RTBT Vacuum I C D - Prelim/Final]	124*	17AUG01	19FEB02
*[RTBT Hardware Test]	179*	12DEC02	29AUG03
*[RTBT Vac HW Install & Test- Summary]	355*	03JAN03	03JUN04

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S N S   248-METER   R I N G
VACUUM SYSTEM CONTROLS